Research
FOR FARMERS

FALL—1961

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Breeding Late-Maturing Timothy

Warble Fly Research at Kamloops and Lethbridge

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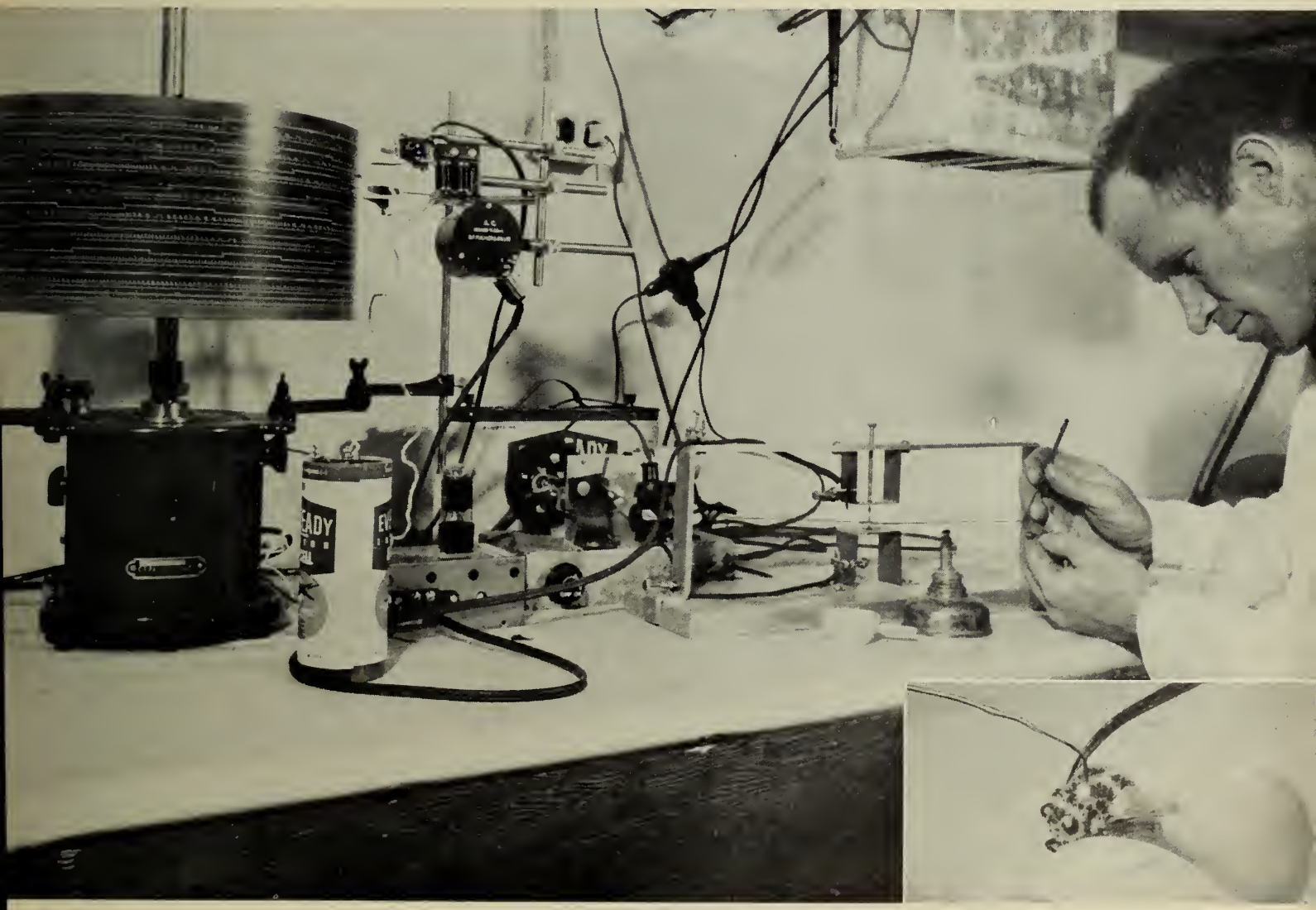
Soil Potassium



CANADA DEPARTMENT OF AGRICULTURE

Research FOR FARMERS

CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

HON. ALVIN HAMILTON, *Minister*
S. C. BARRY, *Deputy Minister*

FALL — 1961

Vol. 6 No. 4

NOTES AND COMMENTS

This issue's center-spread features warble fly research (note cover photo, too) being conducted at Kamloops, B.C., and Lethbridge, Alta. Cattle management requirements in these areas are determined by different sets of conditions. The spray method, for example, is considered more suitable in Alberta's prairie ranges than in British Columbia's mountains and plateaux. We asked Mr. Rich of the Kamloops Entomology Laboratory to touch on his work as it applied to the bolus, injection and feed additive methods, and the latest yet-to-be-approved-in-Canada treatment known as the "pour-on" method. On the other hand, Mr. Khan of the Lethbridge Research Station describes his work with systemic insecticide sprays and reports on the experience of the Forestburg project. Mr. Khan also comments on the "pour-on" treatment. For an up-to-the-minute account, read "Combined Operations Attack on Warbles" . . . Pages 8 and 9.

* * *

The Fredericton Research Station has added another potato variety to its list of research achievements. Licenced on September 11 last, Hunter is a white, midseason to late variety, field immune to virus X, carries the gene R1 for resistance to late blight, and is resistant to black leg and the eastern form of Fusarium rot. It has been under test in New Brunswick for eight years and has undergone extensive trials in the Maritime Provinces under the supervision of the Atlantic Regional Potato Breeding Committee and throughout Canada in the national system of trials.... Hunter appears to show promise in Ontario and Quebec, and is particularly adapted to the Maritime region. Its keeping quality in storage is excellent. It has proved superior in yield and dry matter content to Katahdin. In addition, cooking scores, covering a seven-year period, averaged 83.0 boiled and 93.2 baked compared to 78.2 and 78.6 for the check variety Katahdin. Although Hunter is a good table variety, it will not make acceptable chips nor French-fry satisfactorily.... Hunter was bred from an original cross involving the wild Mexican species, *Solanum demissum* (L), and a seedling of Irish Cobbler and Katahdin parentage. A system of back-crossing utilizing Katahdin and Green Mountain was used. A 834C (29) bred by Dr. William Black of Scotland was used in a final cross and provided the field immunity to virus X.

"*Research for Farmers*" is published quarterly by the Canada Department of Agriculture. Its purpose is to help keep extension workers informed of developments in research and experimentation as carried on by the various units of the Department.

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Cover Photo: **Adult worble fly (inset) being ottoched to flight mill in study of reactions under olternoting light intensities. Graph records activity, scrotchy line indicoting peok flight period when control meosures con be opplied.**

Left: Hereford × bison cow, age 22 years.
Above: Typical winter scene in southern Alberta.
Below: Brahman × Hereford cow with ¼ Brahman calf.

Surprising Results from Experiments at Manyberries, Alta.

Hair and Winter Hardiness in Beef Cattle

H. F. Peters

When snow covers the ground, the temperature drops to —40° F., and no shelter is in sight, the ability to withstand cold becomes an important factor in beef cattle survival. Even under somewhat less extreme conditions the ability to perform satisfactorily in cold weather is an important economic factor. What is winter hardiness and how can it be measured then become problems of considerable significance in selection of breeding animals.

Most animals in our climate develop a winter hair coat quite different from the summer coat. One may assume that this is an evolutionary development to provide necessary winter protection. A further logical assumption is that differences in hair coat thickness would be reflected in differences in winter hardiness of performance under winter conditions. At the Experimental Farm, Manyberries, Alta., this is being investigated and some surprising results have turned up.

It was observed that Cattalo cows, animals resulting from bison and domestic cattle crosses, were more willing to graze in severe winter weather than Hereford, Angus, or Shorthorn cows. Measurements showed that the Cattalo had thicker hair coats, that is greater weight of hair per unit area of skin, than the domestic animals. Brahman cows, on the other hand, had much less hair cover. They did not winter as well as Hereford cows when results were measured in winter gains in sheltered feed lots. Up to this point the original assumption seemed to be justified. Hair coat thickness was important.

Further studies with Brahman × Hereford crossbreds, Herefords, and Cattalo calves in feedlots cast some doubt on the general validity of the assumption. In fact, it was shown that calves with the heaviest hair coats made the lowest winter gains. The full import of these results is not known. Further studies are under way at Manyberries and Lethbridge to determine whether other properties of the hair coat, such as fiber density, may be better criteria.

In the meantime it seems likely that for the immediate future selection for growth rate will have more chance of success than a program based on some indirect measure such as hair coat thickness. It is apparent that genetic differences in winter hardiness do exist. All that remains is to find the simplest and most accurate method of measuring the characteristic.

Dr. Peters is Superintendent, Experimental Farm, Manyberries, Alta.

Left: Cattalo bull of about ⅛ bison breeding. *Right:* ¼ bison Cattalo cow.

Cabbage Maggot Control

Ray F. Morris

Top: Rutabagas severely injured by cabbage maggot. *Middle:* Rutabagas treated with granular heptachlor. *Bottom:* Rutabagas (left) from plot that received pre-planting band application of granular aldrin; no treatment (right).

Experiments at St. John's, Nfld., Experimental Farm disclose effective methods for controlling root maggot in rutabagas.

CANADIAN FARMERS who specialize in the production of cruciferous crops, particularly cabbage, cauliflower, and rutabagas, suffer heavy losses due to repeated attacks by the cabbage maggot. It was not until the recent introduction of chlorinated hydrocarbon insecticides that a major break-through in controlling the insect was accomplished. These made possible the development of satisfactory controls for maggot attack on cabbage, cauliflower, and radish, but nothing was available to control root maggot damage in rutabagas, a crop of great importance in Eastern Canada.

Chemical Control

Insecticides used for cabbage maggot control are formulated in different ways, as emulsifiable concentrates, dusts, wettable powders, granules and insecticide-fertilizer mixtures. Emulsifiable concentrates and wettable powders are used in planting water and post-planting drenches. Dusts, granules, and insecticide-fertilizer mixtures are used as soil treatments at planting time.

The introduction of the chlorinated hydrocarbon insecticides, particularly heptachlor and aldrin, provided a new approach to root maggot control. These insecticides are most effective if concentrated in the soil around the roots of the plant. On the other hand, broadcast applications of insecticides and insecticide-fertilizer mixtures are not recommended because they are ineffective and also destroy a great many beneficial insects that move through the soil.

The author is a vegetable insects specialist with the Experimental Farm, St. John's West, Newfoundland.

Rutabagas

The most economical and effective method of maggot control in rutabagas, we found, was to apply *granules* or *wettable powders* of heptachlor or aldrin in a 5-inch band along the row at seeding time. Twenty pounds of 25% wettable powder per acre or 100-125 pounds of 5% granules per acre is recommended. These materals are most effective when worked into the soil to a depth of 2 inches.

In our experiments at St. John's in 1959 and 1960 we found that *insecticide-fertilizer mixtures* containing heptachlor and aldrin will adequately protect rutabagas. However, the chemicals must be properly placed in the soil and supplied in sufficient quantities to provide maximum protection. These mixtures were most effective when applied on the soil surface in an 8-inch band and then worked into the soil to a depth of 2 inches. When placed more than

Left: Cabbage root that received an aldrin drench. *Right:* No treatment.

Staphylinid *(left)* and cynipid *(center)* parasites of cabbage maggot. Parasitized cabbage maggot puparium *(right)* showing escape hole of staphylinid parasite after destroying pupa.

2 inches below the surface they provided little or no protection. Sufficient quantities of the mixture must be used to ensure that 5 pounds of actual insecticide per acre is applied. In all cases, however, we found that insecticide-fertilizer mixtures were less effective than direct applications of the insecticide.

Transplants

Other experiments involving transplants recently conducted in Eastern Canada showed that heptachlor and aldrin were as effective as the more recently introduced organophosphates for maggot control in cabbages, cauliflower, broccoli, and Brussel sprouts. Five per cent granules of heptachlor or aldrin banded along the row in a 5-inch band at transplanting, or concentrated around the plant stem immediately after transplanting, at 80 to 100 pounds per acre, gave adequate protection throughout the entire season. In field trials with cabbage transplants at St. John's, we found that a post-planting drench of heptachlor or aldrin, one pint of 20% emulsifiable concentrate in 40 gallons of water at 6 oz. per plant, was slightly more effective than applications of granules but was more difficult to apply. This drench had to be applied within five days of transplanting and one application was sufficient.

Natural Control

The cabbage maggot is attacked by several important predaceous and parasitic insects. In some years, up to 60 per cent of the puparia have been destroyed but in general, these parasites will not reduce an infestation adequately. Populations of staphylinid and cynipid parasites have been reduced 100 and 80 per cent, respectively, with recommended applications of aldrin and heptachlor under Newfoundland conditions. Investigations at Prince Edward Island suggest that higher root maggot infestations may occur when insecticides are broadcast than when no treatments are applied, simply because predators and parasites are effected more than the pest.

Future Control Methods

Insect resistance to insecticides is a problem that concerns future control methods. Seed pelleting and the development of maggot-resistant cabbages and rutabagas may be expected to get their share of attention.

Today, insect resistance to insecticides is a serious problem confronting entomologists. Resistance has not yet appeared in local cabbage maggot populations; however, it has been reported from the State of Washington and from the southern tip of Vancouver Island. This may be a prelude to future widespread resistance similar to that recently developed by the onion maggot to chlorinated hydrocarbons.

Present day insecticides generally fall within two classes—chlorinated hydrocarbons such as aldrin, DDT, heptachlor, dieldrin and chlordane, and the organiphosphorus compounds such as parathion, malathion, Thimet, Guthion, ethion and diazinon. If the cabbage maggot develops resistance to hydrocarbon insecticides we must be in a position to recomend other insecticides such as the organophosphates. Recent research conducted by the Experimental Farm, Charlottetown, P.E.I., indicates that Thimet, parathion and Guthion are the most effective organophosphates for cabbage maggot control in rutabagas but this effectiveness could change with developing resistance in the maggot. Should resistance develop to this group also, we shall have to look for more efficient materials.

Seed pelleting experiments conducted at St. John's in 1960 show some promise for root maggot control in rutabagas. A combination of heptachlor and the fungicide captan gave a fair measure of control while many other treatments were ineffective. Further research to determine if the seed can carry an adequate amount of insecticide for complete control will be continued in 1961.

The possibility of developing varieties of cabbages and rutabagas resistant to cabbage maggot attack is not being overlooked. Some progress in the development of rutabagas highly resistant to the cabbage maggot has already been made by research workers at the Department's Research Station, Fredericton, N.B. In the meantime, similar research on the development of resistant cabbages continues at Ottawa.

Flowers and tomatoes in growth room where light intensity can be adjusted for different plants; durable day and night temperatures and required humidity also provided.

ARTIFICIAL LIGHT

With it, researchers can regulate growing conditions and obtain several test crops a year

W. Kalbfleisch

ARTIFICIAL LIGHT is greatly increasing research in plant breeding, physiology and disease control. In the past, a crop could be tested only once in the field during the summer season. With greenhouses, a second test crop could be grown, but growth was restricted because of limited light during the short winter days. However, by using artificial fluorescent, and incandescent light, growing conditions can be regulated to produce test crops several times a year.

On a clear, bright summer day, field crops receive sunlight having an intensity of approximately 10,000 foot candles, although the average light during the growing season is roughly 4,000 foot candles. To appreciate this tremendous amount of light, one has to remember that "one foot candle" is the light given off by one tallow candle at a distance of one foot. Comparatively speaking, a 200-watt bulb in a modern light fixture over your dining room table produces an average intensity of about 25 foot candles.

For agricultural research purposes, the Engineering Research Service has constructed many types of lighting equipment. The light provided by these fixtures or assemblies, ranges from 8 to 8,000 foot candles. Some research projects require only a few foot candles to keep a plant awake in a growth room. In other cases 1,000 to 5,000 foot candles may be needed to grow plants for breeding experiments. For these experiments, light bulbs and tubes are assembled in frames 8 feet square and hung from the ceiling of a small growth room. The test crop is placed on a table below the lights and the room is cooled by refrigeration. Time clocks are provided to regulate the length of day or daylight hours and thermostats control the day and night temperatures.

Light intensity from fifty 200-watt fluorescent tubes and 50 incandescent bulbs exceeds 6,000 foot candles. Thermostats on rear wall control temperatures.

A factor that must also be considered is that the foot-candle method of measurement indicates light as it relates to the sensitivity of the human eye, and to most photographic film. This phase of light has a predominance of green and yellow colors and does not cover the full span of colors in the proper proportion for normal plant growth. As yet, artificial light has not been produced that will duplicate sunlight, but the type of light bulbs now available do aid research.

The measurement of heat energy produced by the sun is another factor that is considered by physicists and engineers. In combination with light energy, the sun produces as much as 200 British Thermal Units per square foot per hour of heat energy that is available to crops. The average heat provided by the sun is roughly equivalent to a household furnace operating at full capacity located on every piece of crop land measuring 50 feet square. Although the comparison is not entirely correct on a scientific basis, it does serve to illustrate the fantastic amount of heat produced by the sun during an average day in the growing season.

At Ottawa, for example, artificially-lit growth chambers are speeding cereal variety research to the extent that within 4-5 weeks wheat can be grown to the 3-leaf stage, be inoculated, and rust resistance of the variety determined. This means that the operation can now be done several times a year. Similarly, barley can be brought to maturity 4 times annually for the purpose of making observations in genetics research. One other example—the effect of smut on a grain crop can be determined within 8 weeks, making it possible to run tests 5 or 6 times a year regardless of the season. The use of artificial light and growth chambers make continuous testing possible throughout the year.

The author is Chief, Engineering Research Service, Research Branch, Ottawa.

Cuttings well established in crossing blocks shortly before covering with cotton cages.

Later-maturing variety sought to enable farmer cut hay at time when weather more favorable and nutritional loss at minimum

Breeding Late-Maturing Timothy

F. S. Warren and *J. E. Langille*

A MAJOR DEFECT in timothy is the rapid decline of its forage quality after the early-bloom stage; mature timothy makes low protein hay. At the Experimental Farm, Nappan, N.S., we are striving to produce a later maturing variety that will enable the farmer to cut his hay at a time when the weather is more favorable, and without as great a loss in nutritive value as formerly. In addition to later maturity, this variety must be leafy, productive, disease resistant and persistent; also it must be capable of rapid regrowth after cutting and be satisfactory in mixtures and in seed production. Our current tests indicate that the new Nappan strain may be satisfactory in all these respects.

This new strain resulted from selection work begun in 1945 when some 5,000 individual plants from the varieties Milton and Drummond and a late Ohio strain were rated for lateness, leafiness and rust resistance. Only 121 selections were good enough to be retained. Cuttings of these were planted in a nursery so laid out that each could be freely pollinated by a random selection of pollen from all the others. Suitable seed was obtained from 84 selections to plant several progeny tests. Precise comparisons were made of the selections for lateness as well as vigor, persistence, leafiness, texture, standing ability, recovery after cutting and production of hay and aftermath. These tests also identified the good combining selections—those able to transmit their superior qualities to their offspring.

We rated eight selections out of the original 5,000 plants satisfactory in all respects. With these selections six different hybrid combinations were made up, designated to utilize the potential hybrid vigor. Two, three, four and eight selection combinations were planned. Cuttings of the selections to be combined were planted in small groups such as those shown above. The second year after planting, each group of plants was covered with a three-foot-square cotton cage (below) to exclude undesirable pollen just prior to blossoming. In this way we produced seed of many different hybrid combinations in a small area each year for three or four years. We used this seed to compare the performance of the hybrids with the other timothy varieties. Our tests were laid out to include the six hybrid combinations and the varieties Climax, Drummond, Milton, Dural, Medon and Loraine. In addition to all the characteristics rated in the previous testing program such as lateness, leafiness,

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Cotton cages over timothy crossing blocks permit production of many different hybrid combinations free of impurities in a small area.

The authors are forage crops specialists at the Experimental Farm, Nappan, N.S.

G. B. Rich

Bolus, injection, feed additive and 'pour-on' methods for warble control investigated at Kamloops in study of cattle management requirements in B.C.

Cattle (center) 'gadding' to escape the warble or gadfly (le
the warble family,

Combined Operatio

FALL SPRAY treatment for warble control is difficult under the cattle management practices generally followed in the range areas of British Columbia. For most of the year, the large herds of the big ranches and the combined herds of the smaller range associations are thinly dispersed over vast areas of rugged and relatively inaccessible range and the cost of gathering them for insecticide treatment is prohibitive. The best time for full herd treatment is before winter sets in. This is the usual time for calf-weaning and separation, herd - culling, and clean-up of the calves that missed earlier branding operations. These gatherings usually take place in the late fall when cold temperatures make it inadvisable to wet cattle with a spray. Since the introduction of the systemic insecticides and the need for treatment before grubs reach the back, our research at the Kamloops Entomology Laboratory has emphasized methods other than spray.

The author is a livestock insect specialist with the Entomology Laboratory, Kamloops, B.C.

Systemic insecticide studies began at the Laboratory in 1949 but, until 1956, the chemicals tested were too poisonous. The first successful systemic insecticide was the Trolene bolus, registered for general use in 1957, but later restricted to use by veterinarians. In our tests since 1956, we have found that Trolene boluses, used before the grubs reach the back, killed 90 per cent of the warbles and, with efficient handling facilities and competent workers, a single crew of men can treat up to 500 wild range cattle daily. In a study of an isolated herd treated annually for 4 years with Trolene boluses, we found that warble grubs were reduced from 32 to 1 per animal by the first 3 treatments but a fourth treatment showed no further reduction. During our investigations, another chemical, Dowco 109, was tested as a bolus in 1957. We found it as effective as Trolene and, because of lower dosage and smaller-sized boluses, treatment was easier.

Because of the labor required to treat animals individually, boluses were not well received by the ranchers. Later their restriction to veterinary usage was considered to have made them too expensive and production of boluses has been virtually discontinued.

In 1957, both Trolene and Dowco 109 were tested as additives to concentrate feed. In 1958, the producing company withdrew Dowco 109 as a test material and introduced Ruelene in its place. We have also made feed additive tests using Ruelene. By measuring amounts of treated feed in troughs, we have found that these chemicals are generally more effective as feed additives given daily for periods of 7 or more days than as a single bolus treatment. One disadvantage arising from the competitive factor in group feeding, is that some slow-feeding animals do not eat enough insecticide for effective treatment.

British Columbia stockmen have always emphasized that injectable insecticides would be particularly suitable to their management and handling practices. In 1959, we tested Ruelene as an intramuscular injection and found it gave warble reductions equal to those obtained by other treatment methods. In 1960, we used another chemical in our tests that almost reduced warbles completely but it gave indications of being too poisonous to justify further trials.

In 1959, some research workers found that a small quantity of concentrated liquid Ruelene poured on the back of an animal would reduce warbles quite as well as

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Cattle grubs (*Hypoderma* spp.) in piece of hide from back of infested animal.

Warb
ing

poderma lineatum (DeVill.) At right, another member of
erma bovis (Linn.)

M. A. Khan

Lethbridge researcher finds systemic insecticide sprays effective in controlling cattle grubs caused by warble flies, although 'pour-on' method under study

Attack on Warbles

In investigations at the Research Station, Lethbridge, Alta., we have found that 0.5 per cent sprays of Co-Ral, a systemic insecticide, are highly effective for the control of cattle grubs caused by warble flies, and lice were also suppressed in the sprayed animals. These results have made it feasible to investigate the eradication of grubs on a territorial basis in the Forestburg district. This project, to start with, is to be a 3-year operation. If the results justify the effort, larger-scale operations are possible. After three years, the results should indicate: the efficacy of systemic insecticides against cattle grubs and lice under field conditions; and the minimum tenure, area, and the organization required for a successful project of this nature.

The Forestburg project involves a 15×20 mile area and has been in progress for two years in co-operation with the Alberta Department of Agriculture, the local Agricultural Service Board, and the Hastings Coulee and the Pleasington Pest Control Associations in the area. Approximately 7,000 cattle on 225 farms were involved in this project. The animals were sprayed during the fall, by the operators of the two associations, with one gallon per head of 0.5 per cent wettable powders of Co-Ral or Ruelene, another systemic insecticide, at a pressure of 350-400 lb. per square inch. Dairy cows, and calves under 3 months old, were not treated unless infested with warbles. If such was the case, they were sprayed with rotenone during the following spring. The cost of spraying one animal was 5 cents for the use of spraying equipment, 15 cents for labor and 15 cents as a token charge for the insecticide, most of the latter being donated by the manufacturers.

The area consisted of a central zone surrounded by a buffer zone five miles wide. Results of the treatments were determined by taking monthly grub counts in treated and untreated herds in the central and buffer zones, and in untreated herds outside the area, during February, March, April and May.

During the first year, 5,193 cattle of all ages were sprayed, 2,636 with Co-Ral and 2,557 with Ruelene. There was a pretreatment average of 18 grubs per calf outside the area and 14 grubs per calf inside the area. Co-Ral and Ruelene sprays reduced the number of warbles by 99 and 94.5 per cent. Lice were also kept under control on the sprayed animals.

During the second year 6,565 animals were sprayed in the fall—4,944 with Co-Ral and 1,521 with Ruelene—and 927 were sprayed with rotenone in the following spring, with good results. We sprayed 2,299 heads more than the previous year because of the increased interest shown by farmers as a result of benefits received from the first year's treatment.

Some of the farmers participating in this project received higher prices, ranging from one-half to one cent per pound body weight, for the warble-free beef animals.

So far, not a single case of toxicity, due to the insecticides, has been reported in this area. During the first year a few Charolais animals started losing hair approximately four weeks after spraying with Ruelene. These animals were parasites and fungal infection. It free from lice and other external was not possible to definitely attribute this condition to Ruelene spray. The addition of vitamin A

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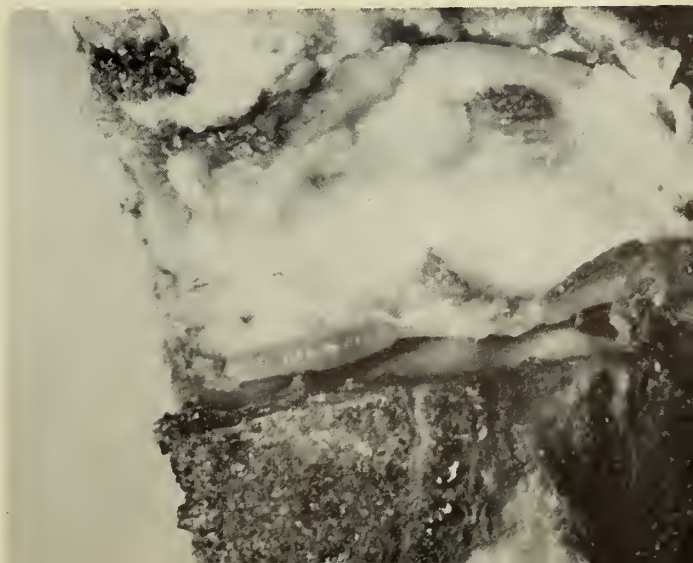
The author is a specialist in livestock insect control, CDA Research Station, Lethbridge, Alta.



Larvae of northern heel flies (*Hypoderma bovis* L.) pass through spinal canal while migrating inside animal.

Mechanical vs. Strip Grazing for Dairy Cows

What Four-Year Study at Kapuskasing Revealed

DAILY mechanical harvesting of forage for cattle in dry lot is said to result in greater animal production per acre than when grazing is permitted. But opinions differ on the value of the method, variously known as mechanical grazing, zero grazing, green chopping, or soiling. Some believe that daily cutting avoids forage loss by trampling and saves energy that cows would expend. Others say that costs of machinery and labor make the method uneconomical for the smaller farmers. Difficulty of harvesting forage after rains creates another problem.

An alternative method is strip grazing. By the use of movable fences, the cattle are given a fresh strip to graze every day. This is said to be superior to continuous or rotational grazing because the cattle have new ungrazed forage offered to them daily. A disadvantage is that labor is required to move fences.

To assess these two systems of grazing, we made a study at Kapuskasing over a four-year period. We used a field that had been harvested for hay for two years and used one year for pasture. One-half of the area was mechanically grazed, the other strip grazed. Each year the field was fertilized with 200 pounds of 11-48-0 fertilizer. Ayrshire cows were used to measure the productivity of the fields. In addition to grass they were fed one pound of grain for each eight pounds of milk produced.

The author is an animal breeding specialist at the Experimental Farm, Kapuskasing, Ont.

L. A. Charette

Our study showed under our conditions that the advantages of mechanical grazing were not sufficient to recommend it over strip grazing on a purely economic basis. A summary of our findings follows.

Over the 4-year period the average milk production per acre (corrected to 4 per cent fat) was 2,294 pounds from the area mechanically grazed and 2,153 pounds from that strip grazed. The cows fed the mechanically harvested forage produced an average of 27.0 pounds daily and those strip grazed produced 28.6 pounds. But mechanical grazing resulted in a more uniform milk flow throughout the grazing season. Also these cows made greater daily body gains—1.06 pounds as compared with 0.78 pounds for those strip grazed.

Articles on these pages discuss pros and cons of Mechanical Harvesting from research experience in Ontario and Alberta.

Cows fed cut forage ate an average of 30 pounds of forage dry matter per day and those strip grazed consumed 26 pounds of dry matter. Cows mechanically grazed required 1.17 acres per cow during the 98-day grazing season and those strip grazed required 1.32 acres. The cows wasted 8.3 per cent of the forage harvested by machine whereas with strip grazing 22.4 per cent was wasted.

More labor was needed with mechanical than with strip grazing It took one man 64 minutes to harvest the forage, haul to the dry lot and place in the feed bunks. The daily average time to move fences on the strip-grazed area was 15 minutes.

A problem with both methods was the difficulty of obtaining sufficient mid-summer forage at the proper stage of growth. This was partly overcome by harvesting surplus forage as silage or hay in the early part of the season. When this was done the cows did not graze below the stubble and consequently the pasture remained in better condition. We noted in this experiment that cows could be placed on pasture in the spring before forage could be harvested. The grass recovered quicker after grazing than after being mechanically harvested.

To sum up, we found that the advantages from mechanical grazing were better body gains, more even milk flow, less wastage of forage and lower fencing costs. Another advantage, but difficult to measure, was that the cows were always close to the barn and to shade in hot weather. Offsetting these advantages were the overhead and operating costs of the necessary machinery, additional labor costs, and the difficulty of harvesting forage after rain.

In areas where the rainfall is well distributed over the pasture season, daily harvesting of forage creates a problem since, regardless of climatic conditions, a load of grass must be hauled in. Often the fields are too wet and the harvesting equipment causes much damage. If mechanical grazing were to yield much more milk per acre and not be handicapped so often by wet conditions, the dairy farmer might seriously consider it. At present the differences between the two types of pasture management are not high enough to warrant recommendation of mechanical grazing.

Dairy cows at Experimental Farm, Kapuskasing, Ont., in mechanical grazing study.

Mechanical harvesting of pasture.

Mechanical Harvesting vs. Rotational Grazing

What Three-Year Study at Lethbridge Disclosed

R. D. Clark
and
D. B. Wilson

MECHANICAL HARVESTING has not appreciably increased beef production per acre over rotational grazing of irrigated pastures at the Lethbridge Research Station. This conclusion is based on the first three years' data obtained from a study comparing the two methods of utilizing irrigated pastures. The forage mixture used consisted chiefly of smooth brome, orchard grass, creeping red fescue, and white clover. Each spring yearling Hereford steers, weighing approximately 600 pounds, were placed on the pasture. No final conclusion has been reached as to the best system to use but many interesting points that affect the relative value of each have been noted. The data obtained on beef and forage production are shown in the accompanying Table.

The greater beef gain per acre from the mechanically harvested fields in 1958 had been expected on the basis of reports and on the theory behind the system. It seemed reasonable that the grass would grow better when the animals were excluded from the pasture and that they would gain faster when confined and fed all they would eat. The lower beef and dry-matter yields from the mechanical harvesting treatment in 1959 were contradictory and somewhat unexpected. Investigation has revealed that higher forage and animal production yields from mechanical harvesting the first year and lower yields in succeeding years have been reported from other places but no satisfactory explanation has been offered.

Results from another experiment being run concurrently at Lethbridge showed that higher yields were obtained when the forage was cut to leave a 2-inch rather than a 4-inch stubble. The reason for the low forage yields under mechanical harvesting then became apparent; the forage harvester was leaving about 5 inches of stubble. The difference was particularly noticeable early in the season. The grazing pastures were ready for use 2 weeks before any cutting could be done on the

COMPARISON OF ROTATIONAL GRAZING AND MECHANICAL HARVESTING

—	Grazed	Mechanical
Beef production per acre (lb.)		
1958	573	739
1959	656	549
1960	696	716
Dry matter yield per acre (lb.)		
1958	7100*	5772
1959	4785*	4633
1960	7091*	5764
Average daily gain (lb.)		
1958	2.20	2.46
1959	2.72	2.67
1960	2.13	2.15
Length of season (days)		
1958	112	107
1959	102	103
1960	103	103

*Yield data determined from cages.

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Yearling steers on irrigated pasture.

mechanically harvested fields. Slower warming of the soil under the heavy stubble probably was an important factor. Also, the forage harvester injured a large proportion of the leaves of the grass stubble, which rendered them ineffective in photosynthesis. In 1960 these conditions were counteracted by cutting to a stubble height of 2 to 3 inches and keeping the flails in a good state of repair.

The dry-matter yield from the grazed fields was low in 1959 also. We have attributed this to insufficient irrigation and nitrogen fertilization. Steps to improve these, and other features of management, were taken in 1960 and increase in yields of beef and forage were obtained.

The length of the pasture season depends on the stocking rate but, under heavy use, it will be only slightly more than 100 days in the Lethbridge area. The stocking rate for these tests was 3.4 steers per acre, which may be considered fairly heavy. Various management practices may be implemented to extend the grazing season. The stocking rate may be reduced in the spring with the excess forage being harvested at that time and fed back later in the season. Concentrates also may be fed to reduce the animal requirement for forage as the season advances. Cattle given supplemental grain during the latter part of the season will go on dry feed quicker than those given no grain and will probably carry a higher degree of finish than those on a complete forage ration.

We are still not convinced that beef production per acre is at a maximum level and, therefore, further refinements are planned for 1961. The grazed plots will be changed from a 3- to a 6-field rotation and the excess growth early in the season will be harvested as hay and fed back later, when growth slows down. For the clipped plots the forage wagon will be modified to prevent any loss of the chopped material. During strong winds some loss of forage is incurred despite efforts to prevent it. The fertilizer application on a per-acre basis will be 50 pounds of phosphorus and 50 pounds of nitrogen in early April, plus 50 pounds of nitrogen in June and another 33 pounds in July. The fields will be flood irrigated up to six times during the season.

On the basis of our experience to date, the advantages of mechanical harvesting compared with rotational grazing appear to be: (1) less fencing is required, (2) watering and supervision of the stock is simpler, and (3) management of the grassland is easier.

The disadvantages of mechanical harvesting are: (1) the initial outlay for equipment in the form of a harvester and self-unloading wagon is high, (2) cutting forage must be done daily, (3) in wet weather harvesting may be difficult or impossible, (4) labor is required at a time when there is usually a shortage of labor on the farm, and (5) a well-drained feedlot is essential and extra bedding is required.

Whether mechanical harvesting is used will depend largely on the individual operator. The somewhat higher yields per acre will have to be balanced against the extra cost of labor and equipment. For the small operator the gains from the higher yields will be lost due to the additional expenses of clipping.

Cattle eating mechanically harvested pasture (PFRA feedlot, Hays, Alta.)

Recording observations in study of pig in a "respiration chamber".

Time-saving Technique . . .

Fat and Protein Changes in the Growing Hog

Measurement of changes speeded up by nutritional balance techniques in respiration chamber

D. W. Friend and *H. M. Cunningham*

THE RESPONSE by the pig to different dietary regimes, measured in terms of the amounts of body protein and fat gained or lost, can be of fundamental importance when studying methods of carcass quality improvement. The effect of dietary differences can be substantiated by carcass appraisal or by back fat measurements but this requires a large number of pigs and a feeding period of several weeks. The use of "nutritional balance" techniques and of a "respiration chamber" at the Experimental Farm, Nappan, N.S., allows an evaluation of such effects on the protein and the fat content of the live animal to be made in a few days.

A "nutritional balance" experiment measures the difference between the ingoing and the outgoing quantities of a nutrient; the source of nutrient intake being the feed ingested. Consideration of the fecal and the urinary losses of nitrogen provides a means of determining the protein status of the animal at various stages of its development; whether it is gaining or losing body protein. The fat status of the animal is determined by measuring the carbon gained or lost by the body. The gaseous carbon losses, in addition to those of fecal and of urinary origin, must be taken into account when doing this.

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Carbon dioxide (CO_2) is usually the only gas accounted for in such studies with pigs. Traces of methane (CH_4) from this non-ruminant animal may be regarded as relatively unimportant. Less than 0.02% methane was detected by the authors in a gaseous sample collected in the apparatus to be described, from each of four fattening pigs.

An apparatus for measuring the gaseous loss is called a "respiration chamber" and many designs have been developed and used for particular purposes. Illustrated is a relatively inexpensive metal chamber made for large-animal nutrition studies at the Nappan Farm.

The test animal is put into a metabolism cage which allows for separate collection of feces and urine. The cage is wheeled into a chamber which becomes air-tight on closing the hinged door. Through the use of transparent plastic material for the sides and roof, the confined animals show no signs of anxiety as formerly when less visibility was provided.

An electric fan circulates the air in the chamber. Temperature and humidity are regulated by a thermostatically-controlled refrigerator unit, connected to a large cooling plate inside the chamber. A vacuum pump draws air from the chamber along the outlet duct, passing it to a flow-meter which records the volume of air flow during the test period. Consequently, fresh air is continually entering the chamber via the inlet duct. The meter also allows representative samples of the air to be collected for subsequent carbon dioxide analysis.

The technique described allows a measure to be made of the effect of various dietary and physiological treatments on body composition. This can provide valuable information when examining methods to control an excess accumulation of carcass fat in bacon hogs.

Metabolism cage used for "nutritional balance" experiments with pigs, sheep or calves.

Left: Determining amounts of potassium with flame photometer.

Below: Potassium fertilizer increases growth of alfalfa in sandy loam, but not in clay loam. A: sandy loam, control; B: sandy loam, potassium added; C: clay loam, control; D: clay loam, potassium added.

SOIL POTASSIUM

Eleven surface samples of Canadian soils from varied locations studied to better understand this essential element.

A. J. MacLean

AMOUNTS and behavior of different forms of soil potassium vary rather markedly with other soil properties, particularly texture. To obtain a better understanding of the relation of different forms of potassium to each other and to other soil properties, potassium in eleven surface samples of Canadian soils has been investigated in considerable detail by the Soil Research Institute, Ottawa.

Soil potassium exists in the following forms: (a) exchangeable potassium adsorbed on clay and organic colloids but readily replaceable with a suitable salt solution, (b) soluble potassium in the soil solution, and (c) non-exchangeable potassium occuring as a constituent of mica, feldspar and clay minerals or representing added potassium bound firmly or fixed in these minerals. Exchangeable potassium is readily available to plants and, when reduced by cropping, there is a tendency for this form to be replenished from the non-exchangeable source. On the other hand, when the level of exchangeable potassium is raised by applications of fertilizer, a portion of the added potassium is fixed in non-exchangeable form.

Exchangeable Potassium

In the experiments at Ottawa, the amounts of exchangeable potassium in the soils before cropping were related to the amounts removed by plants in pot tests. Reduction in exchangeable potassium with cropping, however, accounted only in part for the potassium used by the plants. Thus, in addition to the exchangeable potassium content, release of non-exchangeable potassium during the cropping period was an important characteristic in determining the capacity of the soil to supply potassium to plants. Furthermore, the results illustrate that the same level of exchangeable potassium in soils of different texture may have entirely different meaning. For example, a well-managed Charlottetown fine sandy loam soil from P.E.I. and an unfertilized Carp silty clay loam sample from eastern Ontario each contained about 292 lb. of exchangeable potassium per acre. In the pot test, reduction of exchangeable potassium with cropping accounted for 76 per cent of the plant uptake of potassium from the Charlottetown sample but only 14 per cent of the uptake from the Carp soil. Release of non-exchangeable potassium from the latter supplied 86 per cent of the plant requirement. Exchangeable potassium in the well-managed Charlottetown soil represented a source of potassium for plants whereas the level of the exchangeable form in the Carp sample was related to a capacity to release non-exchangeable potassium. Usu-

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ally, the amounts of exchangeable potassium and the capacity to release non-exchangeable potassium increase with increasing clay content of soils.

Soluble Potassium

Soluble potassium in the soil solution is of insufficient quantity to significantly supply potassium to plants. Nevertheless, the amounts present may reflect differences in past management. The water-soluble potassium in the well-managed Charlottetown soil was 62 lb. of potassium per acre as compared with only 16 lb. in a sample of similar soil except that past management was much inferior. A sample of Granby sandy loam collected from experimental plots at Ottawa, and known to have received no manure or fertilizer in the past 35 years, contained only 5 lb. of water-soluble potassium per acre. The Carp sample referred to above contained only 12 lb. of water-soluble potassium per acre but this soil, having a relatively high clay content, supplied considerable potassium from non-exchangeable form. These and other results have shown measurement of potassium in solution to be useful in diagnosing supply of potassium in soils possessing similar characteristics, particularly texture, but differing in management,

Non-exchangeable Potassium

Since the potassium-supplying power of soils over a period of years depends on release of non-exchangeable potassium, different laboratory techniques for measuring this form of potassium were compared. These included (a) repeated extraction of samples with boiling nitric acid, (b) continuous leaching with dilute solution of hydrochloric acid, and (c) uptake of potassium by exchange resin mixed with the soil in moist condition. The results obtained were related to estimates of non-exchangeable potassium removed by plants, and show that such techniques are useful in differentiating soils with respect to slowly available reserves of potassium.

Fate of Potassium

Another aspect of the potassium problem concerns the fate of potassium added to soil. When a high rate of potassium (1170 lb. K/acre) was applied to the eleven soils and the samples were subjected to repeated cycles of wetting and drying, a considerable portion of the added potassium was fixed in non-exchangeable form. The degree of fixation in the different soils varied from 16 to 71 per cent of the amount added. Differences in soil texture accounted in part for variations in capacity of the soils to fix potassium. For example, the portion of added potassium that became fixed in non-exchangeable form was 32 per cent in Castor fine sandy loam, 49 per cent in Mountain sandy loam and 71 per cent in Carp silty clay loam. These samples from eastern Ontario contained 8, 15 and 36 per cent clay, respectively. Results of other experiments with different-size particles separated from the soils confirmed the relationship between fixation of potassium and size of soil particles but also showed that considerable fixation occurred in the fine silt particles. In materials separated from five eastern Ontario soils, the average fixation of added potassium was 62 per cent in the clay, 51 per cent in the fine silt and 11 per cent in the coarse silt.

To illustrate the fate of potassium added at more practical rates, results obtained with samples of a Caribou silt loam from New Brunswick are given above.

FATE OF POTASSIUM ADDED TO CARIBOU SILT LOAM.

Potassium added	Before cropping in pot test		After cropping in pot test	
	Water-soluble potassium	Potassium fixed	Water-soluble potassium	Potassium fixed
lb./acre	lb./acre	%	lb./acre	%
0	26	—	20	—
156	28	70	22	75
312	37	63	30	70

The proportion of added potassium that became fixed in non-exchangeable form was slightly less when the rate of application was increased. Reduction of the level of potassium by cropping in the pot test increased fixation of potassium. As the nutrient was released from non-exchangeable form during cropping, sites in the minerals became available for trapping of added potassium. The results show that from about two-thirds to three-quarters of the added potassium was held in non-exchangeable form, whereas the remainder would be expected to be immediately available to plants. The water-soluble potassium content of the samples reflected the influence of cropping. Based on the amounts of this form of potassium, approximately 234 lb. of potassium would be required per acre to raise the soluble potassium in the depleted samples to the more satisfactory level that prevailed before cropping. Although fixation of potassium increased the amounts that must be applied to meet crop requirements, this same process is advantageous in reducing losses by leaching and in providing slowly available reserves of potassium.

In farm operations fixation of added potassium is often reduced by the practice of placing the fertilizer in bands near the seed with minimum contact with the soil.

Clay loam soil continues to supply potassium to ninth successive crop in greenhouse.

Warble Fly—G. B. Rich . . . *from p. 8*

spray, feed, or injection methods of treatment. This was the origin of the so-called pour-on treatment that is now being tested at Kamloops and elsewhere. In 1960, several other chemicals were introduced for pour-on testing and Ruelene and three others were tested at Kamloops. In rather extensive trials, we found Ruelene to be as effective as a pour-on as in previous tests by other application methods. The formulations of two of the other three were unsuitable for general use and these will be tested this year in new and improved formulations. The third chemical tested was more effective than Ruelene, but because it proved poisonous as an injectable, we have doubts concerning its safety for general use.

The results of these pour-on tests were impressive. The ranchers who saw the insecticide applied and saw the effect on the warbles thought that the method would be more suitable to British Columbia conditions than the injection method. Less than a fluid ounce was used per 450-pound calf. It caused no skin irritation, and, because of the small amount of liquid, there was no danger when treatment was made in cold weather. Animals were rapidly and easily treated in an ordinary corral chute. The only equipment required was a small measuring cup or ladle.

Research in this field has developed rapidly since 1956 and has resulted in an optimistic feeling on warble control. However, as new compounds and new treatment methods continue to appear, these will require scientific testing.

Warble Fly—M. A. Khan . . . *from p. 9*

to the feed relieved the symptoms to some extent. This condition was not encountered during the second year. The safe use of these insecticides on a large scale without any visible side-effects in the sprayed animals has been demonstrated.

'Pour-on' Method Studied

We are studying other methods of cattle grub control at Lethbridge. These involve insecticides being given as feed additives or injections, or being applied to limited areas of the body instead of wetting the whole animal. Trolene FM-40 has been on the market on a trial-use basis as a feed additive. Injectable insecticides are still in an experimental stage. Insecticidal ointments were evaluated at Lethbridge. In our first experiments on the application of chemicals to limited areas of an animal's body, we evaluated insecticidal ointments. Since then, however, liquid formulations have been developed that can be poured on the animal's back in a thin stream along the spine.

We are testing 'pour-on' formulations and a Ruelene product may be on the market in the near future. The advantages of using this convenient method are obvious. To treat a 400-pound calf, only four ounces of liquid are required instead of one gallon for spraying and wetting the whole animal—an undesirable method in cold weather. With the pour-on method, spraying equipment is not necessary; all that is required is a long-handled dipper.

Disadvantages? We found that the insecticide sometimes caused skin irritation immediately after treatment. This may cause wild running and exhaustion but can be prevented by keeping the animals penned for an hour after treatment. We found no ulceration or hair loss in the treated areas but a considerable amount of scale formation.

We have also experimented with the pour-on method for lice control but results have not been promising.

A chute is essential for holding even a small number of animals for 'pour-on' application. However, this is not a disadvantage since on any livestock farm a chute is an asset for spraying cattle, and is preferred by some farmers instead of a crowded pen.

Breeding Late-Maturing Timothy . . . *from p. 7*

productivity, disease resistance and so on, samples of hay of each variety were analysed for protein and crude fiber content.

We found that each of the hybrids averaged fifteen days later in maturity than Climax. But their hay yields, over a three-year period, were practically the same as for Climax. The hybrids were also closely comparable for resistance to lodging, recovery after cutting and production of aftermath. As all plots were cut when the hybrids were at the proper stage for hay, the other varieties had already begun to decline in feeding value. We learned that the protein content of the hybrid combinations ranged 10 to 30 per cent higher than Climax but they were slightly lower in fiber content.

As in breeding any crop the process with timothy is a continuous one. For example in 1958 a new selection nursery was established consisting of over 6,000 individual plants representing 61 different lots from 16 countries. We examined each plant for lateness and agronomic desirability and rated about a hundred selections satisfactory enough to be retained. Although further large plantings are being made each year including new material, we are concentrating on those lots already determined to be most productive of the desired type. The hybrid combinations are useful in this way and hundreds of plants have been selected for further study. The chances of making definite improvement in timothy look good considering how much was accomplished from an initial survey of only 5,000 plants.

ROGER DUHAMEL, F.R.S.C., Queen's Printer and Controller of Stationery, Ottawa, 1961